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SUMMARY OF WORLDWIDE RESEARCH ON LOBSTER ESCAPE VENTS

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INTRODUCTION

The mortality of undersize (sublegal) lobsters after they are trapped and subsequently released has been a major problem in many lobster fisheries throughout the world. It is a significant problem since even a small level of mortality could result in a substantial loss of revenue to a fishery, considering the value of the individual lobster plus the loss of reproductive input into the resource. In comparing historical catch rates of spiny lobster at Necker Island, Polovina[1] found there was a 26% reduction in the population of sublegals between 1977 and 1985. Polovina theorized that this reduction may have been due to a number of factors, including mortality of sublegals which are caught in traps and released, and direct fishing mortality on undersize lobsters retained illegally in the catch. Assuming, as a result, 26% fewer legal animals are landed, this translates into a loss of $275,000 to the industry at Necker Island alone.

Measures to reduce this type of mortality have been initiated by lobster fisheries located in Western Australia, New Zealand, Canada, Florida, California, New England, as well as Hawaii. In the following review I will attempt to summarize the current status of escape vent research at each of these locations.

AUSTRALIA

The most extensive work on the mortality of sublegals after release has been undertaken in Western Australia, an area with one of largest lobster fisheries in the world, where the average annual catch between 1974 and 1982 was nearly 10,000 metric tons (MT). The 1981-82 season produced income of about $A71 million to the 780 boats participating in the fishery (Brown and Caputi 1983). Catches of the Australian rock lobster, Panulirus cygnus, have remained fairly stable since the early 1960's, due at least in part to a number of management measures initiated as the fishery developed (Hancock 1981). These measures include limited entry since 1963, limited fishing areas, closed seasons, a minimum legal size of 76 mm carapace length (CL), restrictions on the design, size and number of traps fished, and a requirement since 1966 that all traps be fitted with escape vents to release sublegal lobsters. Detailed studies have been carried out to estimate the effect of sublegal lobster mortality due to handling (Bowen 1980; Morgan 1980; Brown and Caputi 1983), and also to ascertain the effectiveness of escape vents (Bowen 1963). Brown and Caputi (1983) showed that handling mortality experienced by sublegal lobsters was a significant problem in the fishery and that the mortality increased proportionally with time of exposure on the surface. They determined that the major factors contributing to mortality include: Prolonged exposure to air and sunlight,

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[1]Polovina, J. J. 1985. Status of stocks of spiny lobsters at Necker Island and Maro Reef, 1985. Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96812, Admin. Rep. H-85-12, 11 p.

physical damage due to handling, displacement from home reefs, and increased predation due to weakened condition after release. Tagging experiments were carried out to document the extent of sublegal lobster mortality in the fishery. Exposure time of 15 min or more resulted in lower recapture rates of tagged animals when compared against controls with zero exposure. Recapture rate was further reduced when displacement and damage due to handling factors were considered. Using this information, it was estimated that 14.6% of all sublegal lobsters caught became unavailable to the fishery during the 1978-79 season due to these combined effects. Adjustment for natural mortality put the figure at 11.4% of the undersize animals lost as a direct result of sublegal lobster mortality (Brown and Caputi 1983). Reduced growth rates due to damage from handling, exposure, and displacement were also documented during the tagging studies. Brown and Caputi (1985) found that this could delay their entry into the fishery, thereby reducing harvestable yield, and increasing the possibility that the lobsters undergo multiple handling since affected animals would remain undersize longer. These injuries and mortality occur despite the use of vented traps and would surely be considerably worse if vents were not in use. During vent trials conducted off the Abrolhos Islands in Western Australia, Bowen (1963) found that traps with vents of 51 mm (2 in.) caught 54% fewer sublegal lobsters compared with non-vented traps, without affecting legal catch. Vents of 57 mm (2 1/4 in.) further reduced sublegal lobster retention, and actually increased the legal catch slighty. Similar results were reported by Wilder (1949) in Canada. Soon after this reseach was completed, the use of escape vents measuring 51 x 305 mm became mandatory in all Australian lobster traps. The vent size was increased to 54 mm in 1972, further enhancing sublegal lobster escapement. Currently, the possibility of enlarging vent size to 55 mm is being investigated and preliminary results are encouraging. It was found that a 1-mm increase in vent height reduces the sublegal lobster catch by 30% without affecting legal lobster take (Brown, R. S., Dep. Fish. Wildl. West. Aust., Mar. Res. Lab., North Beach, WA (Aust.), pers. commun., 1984).

NEW ZEALAND

The lobster fishery for Jasus edwardsii and to a lesser extent J. verreauxi has been New Zealand's most important domestic fishery since the mid-1950's (Annala 1983). As in Australia, various regulations have been initiated in an effort to protect the fishery. A more recent regulation (1970) is the requirement that escape vents measuring 54 x 300 mm and 38 x 152 mm (Otago area) be used in all traps. This requirement is based upon research carried out by (Richie 1966) and (Bain 1967) among others, that showed vented traps to be an effective way of releasing sublegal lobster without compromising legal catch. Unfortunately, little follow up research has been done to document any change in catch composition that may have resulted after the vented traps requirement became law.

CALIFORNIA

In the course of a life history study on the spiny lobster Panulirus interruptus (Lindberg 1955) found that a 51 mm (2 in.) vent placed in a standard lath lobster trap reduced sublegal retention by 68%. Based on this, he recommended that all lobster traps used in California have an escape vent 51 mm wide. The California State Legislature enacted a regulation in 1957 requiring 51 mm vents in all lath traps and a 51 x 102 mm (2 x 4 in.) minimum inside mesh measurement in all wire traps. The California Department of Fish and Game (CDFG) continued experiments with escape vents for the two chamber wire mesh trap used in this fishery during 1972. Apparently a 51 mm vent was not large enough to allow for sufficient sublegal escapement. A study conducted by CDFG in 1973-74 which was designed to identify problems in the fishery, found that retention of sublegal lobsters (<83 mm CL) was still the largest single factor contributing to the continued decline of lobster stocks in California. Researchers found that traps fitted with a vent measuring 60 x 292 mm (2-3/8 x 11-1/2 in.) showed a decrease in the retention of sublegal P. interruptus of up to 80% and a slight increase in legal catch (Odemar et al.[2]). This prompted CDFG to recommend that "all lobster pots in California be constructed of 51 x 102 mm mesh (2 x 4 in.) 48 x 98 mm (1-7/8 x 3-7/8 in.) (inside measurement) and be fitted with a rigid rectangular escape vent with an inside measurements of not less than 60 x 292 mm (2-3/8 x 11-1/2 in.). At least one vent must be located parallel to and within 2 in. of the floor on the outside wall of each chamber of the trap and be clearly accessible to the lobsters." These recommendations became law during 1976-77 and a 75% decrease in sublegal lobster catch per trap occurred during that season (Miller[3]). Size-frequency analysis of more recent catch data has shown a dramatic increase in the size range of lobsters retained and there has been a steady increase in the number of legal lobsters caught by commercial fishermen (Miller see footnote 2) (Fig. 1). In addition, since 1977 CDFG scientists have noted an increase in the number of sublegal lobsters at many fishing locations (Fig. 2). Initially fishermen in California were generally opposed to the new vent requirement, but as the benefits of increased legal lobster catch per trap and reduced sorting and handling of sublegal lobsters became apparent, most fishermen have changed their opinion and are now in favor of the provision.

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[2]Odemar, M. W., R. R. Bell, C. W. Haugen, and R. A. Hardy. 1974. Report on California spiny lobster, Panulirus interruptus (Randall) research with recommendations for management. Presented to the California Fish and Game Commission, July 25, 1975, Monterey, California, 98 p.

[3]Miller, K. Southern California commercial spiny lobster fishery. Unpublished data presented at 1985 CALCOFI conference. Dep. Fish Game, Long Beach, CA 90813.

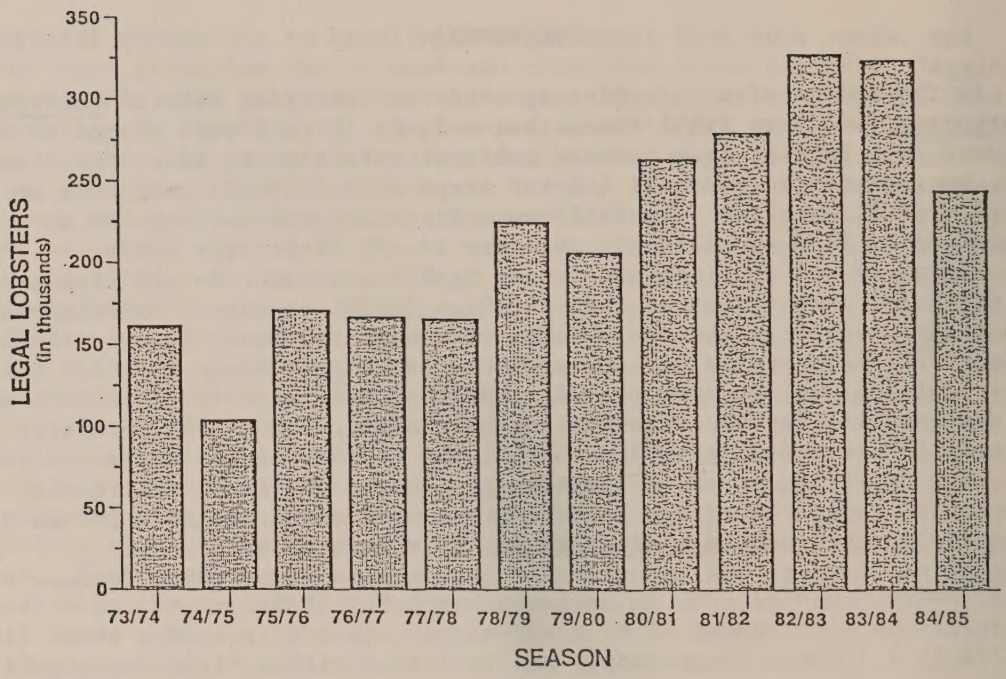

Figure 1.--Total seasonal catch of legal lobsters from commercial fishermen for southern California. (See text footnote 3.)

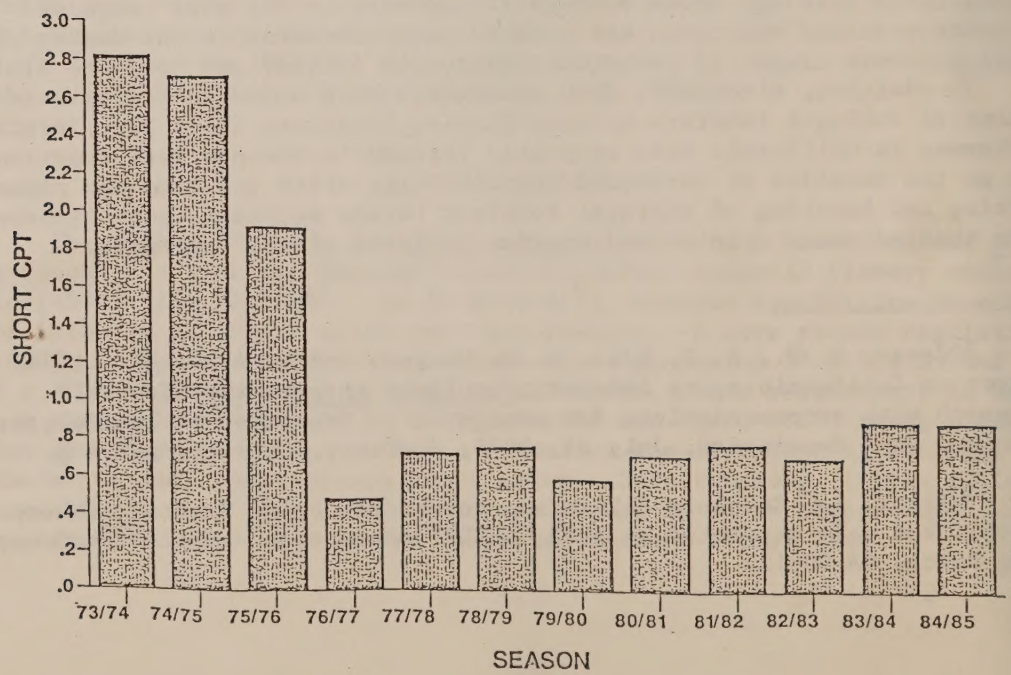

Figure 2.--Sublegal ("short") spiny lobster catch-per-trap (CPT) hauled in the southern California fishery. (See text footnote 3.)

FLORIDA

Similiar research has been conducted by the Florida Department of Natural Resources' Division of Marine Resources (FDNR) for P. argus. Lyons and Kennedy (1981) found that a 63-83% loss to the fishery results from either illegal harvest of undersize (<76 mm CL) animals or from fishery induced mortality of sublegal lobsters. In Florida it is legal to use undersize lobsters in traps as attractants. Researchers placed lobsters in sealed traps after exposure times of 0.5, 1.0, 2.0, 3.0, and 4.0 h before placing the traps back in the water. After 4 weeks, mortality was 3.3% for the control animals and ranged from 12.3-26.3% for the exposed animals (Lyons and Kennedy 1981). They also suggested that fishery induced lobster injuries can substantially affect yield by slowing growth thus delaying entry into the legal fishery. Davis (1981) verified this during tagging studies undertaken in Biscayne Bay, Florida during 1976-77. The growth rate of recaptured lobsters was carefully monitored and the extent of injury noted. In addition to documenting slower growth, it was found that the growth rate of P. cygnus with minor injuries (i.e., five or fewer appendages missing) was nearly identical to more seriously injured lobsters. Davis proposed that injuries such as these could adversely affect recruitment, since injured animals mature at a smaller size, thus reducing fecundity. A consequence of this research was the recommendation that an inexpensive bait be found to replace sublegal lobsters now used as attractants and that escape vents be required in all traps to minimize the handling of sublegal lobsters. A study was initiated in 1980 to evaluate the effectiveness of escape vents in reducing the catch of sublegal lobsters, thereby curtailing losses resulting from handling (Kennedy[4]). Experiments were conducted using separate standard Florida wood slat lobster traps with 51 mm (2 in.) and 58 mm (2-1/4 in.) vent heights. The catch from these traps was compared against that from control traps. It was found that the vented traps caught considerably fewer sublegal lobsters and a higher percentage of legal lobsters than the control (Table 1). Recently, preliminary data (Hunt and Lyons 1985) indicate a 75% reduction in the retention of sublegal lobsters using a 51 mm escape vent, although legal catch was also reduced. The reduced legal catch is thought to have occurred as a consequence of the decreased size frequency of the current Florida lobster population. Apparently few large legal lobsters are now available to the fishery. This lack of large animals, entering the traps combined with the effects of escapement of small legals from vented traps, is responsible for the overall reduction in legal catch rate. The researchers feel, however, that the increase in modal size resulting from the use of vented traps and the corresponding increased abundance of legal lobsters will offset any apparent reduction in legal catch rate.

Research in this area is continuing and the FDNR is confident that subsequent data will affirm that escape vents are a viable management tool for Florida's spiny lobster fishery.

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[4]Kennedy, F. S., Jr. 1983. Effectiveness of escape gaps in traps for spiny lobsters, Panulirus argus. Fla. Dep. Nat. Res., St. Petersburg, Fla.

Table 1.--Catch rates in traps with escape vent and standard spiny lobster traps in Florida Bay, 18 February-10 December 1980 (from Kennedy 1983).

Lobster size (CL)	2 in. gap 109 trap pulls	2-1/4 in. gap 102 trap pulls	Standard 249 trap pulls
68	49	61	
68-70	8	1	No data
71-73	12	1	
74-76	29	1	
Total	98	64	356
Sublegal catch rate	0.90/trap pull	0.63/trap pull	1.43/trap pull
77-79	31	2	
80-82	33	6	No data
83-85	20	13	
85	25	25	
Total	109	46	75
Legal catch rate	1.00/trap pull	0.45/trap pull	0.30/trap pull

NEW ENGLAND

The Rhode Island Division of Fish and Wildlife conducted experiments with the American lobster, Homarus americanus, in 1976 and conclusively demonstrated the effectiveness of vented traps for this species (Forgerty and Borden 1980). The overall catch rate of sublegal lobsters was reduced by 79% in traps with a 42 x 152 mm escape vent. The ratio of sublegal to legal lobster was 1.375:1 in the vented traps and 2.746:1 for the control traps. In addition, it was found that vented traps consistantly caught more legal lobsters. The overall mean catch per trap haul of legal lobster was 0.945 for the vented traps compared with 0.848 for the traps without vents. The difference in legal lobster catch rate between the two trap types was ascribed to the premise that non-vented traps reach a saturation point that prevents additional lobsters from entering. Sublegal lobsters in the traps take up space that could be utilized by legal lobsters. Conversely, vented traps allow sublegal lobsters to escape, creating more room for legal lobsters. Similar findings were obtained during trials conducted off the coast of Maine from 1971 to 1973 (Krouse and Thomas 1975). Based on these studies the Maine Department of Marine Resources recommended that all lobster and crab traps fished in Maine waters should have a rectangular escape vent not less than 44.5 x 152.4 mm or at least

two circular vents not <58 mm in diameter (Krouse 1978). Presently, escape vents are required by law in all lobster producing states throughout New England. As in California, initial resistance by fishermen has shifted to popular acceptance. In fact many consider the vent requirement to be one of the more useful management tools to come out of the fishery (Krouse, J. S., Maine Dep. Mar. Resour., pers. commun. 1986)

HAWAII

Escape vent research was carried out in Hawaii during the latter part of the 1970's for P. marginatus (Paul 1982) and the results were predictably similar to those of the other researchers. Although little research has been done to quantify sublegal lobster mortality in Hawaii, Gooding (1985) identified similar factors to those in Australia as contributing to this mortality (i.e., exposure, displacement, and predation). During field observations conducted in the Northwestern Hawaiian Islands (NWHI), Gooding documented extensive predation of lobsters by ulua (Caranx spp.), after release from a vessel at the surface and via a releasing device at the bottom. Experiments were initiated at the National Marine Fisheries Service (NMFS), Southwest Fisheries Center Honolulu Laboratory in 1984 to test the feasibility of using escape vents in the black plastic lobster traps that have been widely adopted by commercial fishermen in Hawaii (Everson et al.[5]; Skillman et al.[6]). The experiments included laboratory work in large tanks using live captured animals as well as field research during mid-1984 and late 1985 on the lobster grounds using vented traps under actual working conditions. Although detailed analysis awaits completion, the data have shown a much reduced catch of sublegal spiny lobsters and an increased catch of legal spiny lobsters when vents are used. Results of vent research conducted on a NMFS cruise of the NOAA ship Townsend Cromwell during November 1985 are shown in Table 2 and 3, Figures 3-4. An upper and lower vent placement was tested against a control without a vent in an effort to reduce the escapement of slipper lobster without affecting spiny lobster escapement. Indications are that the upper vent works best in accomplishing this, but comprehensive size-frequency analysis must be undertaken before any conclusions can be drawn. The data are included to illustrate the dramatic difference in catch rate of spiny lobster between the two vented traps and the control traps. Future research will concentrate on further reducing slipper lobster escapement.

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[5]Everson, A. R., R. A. Skillman, G. L. Kamer, and J. P. Draper. 1984. Interim report on the laboratory trials phase of the spiny lobster escape vent experiment. Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96812, 9 p.

[6]Skillman, R. A., A. R. Everson, and G. L. Kamer. 1984. Prospectus escape vent experimental procedure for the spiny lobster fishery under management of the Magnuson Fishery Conservation and Management Act. Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96812, Admin. Rep. H-84-13, 11 p.

Table 2.--Lobster catch at Necker Island from 18 to 24 November and from 4 to 8 December combined.

Type	Spiny lobster			Slipper lobster		Traps fished
	Legal	Sublegal	Berried	Legal	Berried	
Control	850	1,456	74	1,465	--	336
Low	977	535	30	297	--	334
High	1,027	622	47	447	--	334
Total	2,854	2,613	151	2,109	--	1,004

Table 3.--Lobster catch per trap for both periods at Necker Island.

Type	Spiny lobster			Slipper lobster		Traps fished
	Legal	Sublegal	Berried	Legal	Berried	
Control	2.53	4.33	0.22	4.36	--	336
Low	2.93	1.69	0.09	0.89	--	334
High	3.07	1.86	0.14	1.34	--	334
Total	2.84	2.60	0.15	2.10	--	1,004

SUMMARY

Successful use of escape vents has been demonstrated in all situations studied. Each of the studies cited previously has reported a reduced catch of sublegal lobsters in vented traps. Many also found legal lobster catch per trap increased when escape vents were used. Vents are required by law in at least four of the areas. In California and New England, where vents have been required for some years, initial resistance by fishermen has gradually changed to acceptance since evidence of their beneficial effects have been documented. Recent data suggest that the use of escape vents in the specific traps used for lobster in NWHI may also benefit the fishery by reducing handling of sublegal spiny lobster without affecting and possibly increasing the legal lobster catch.

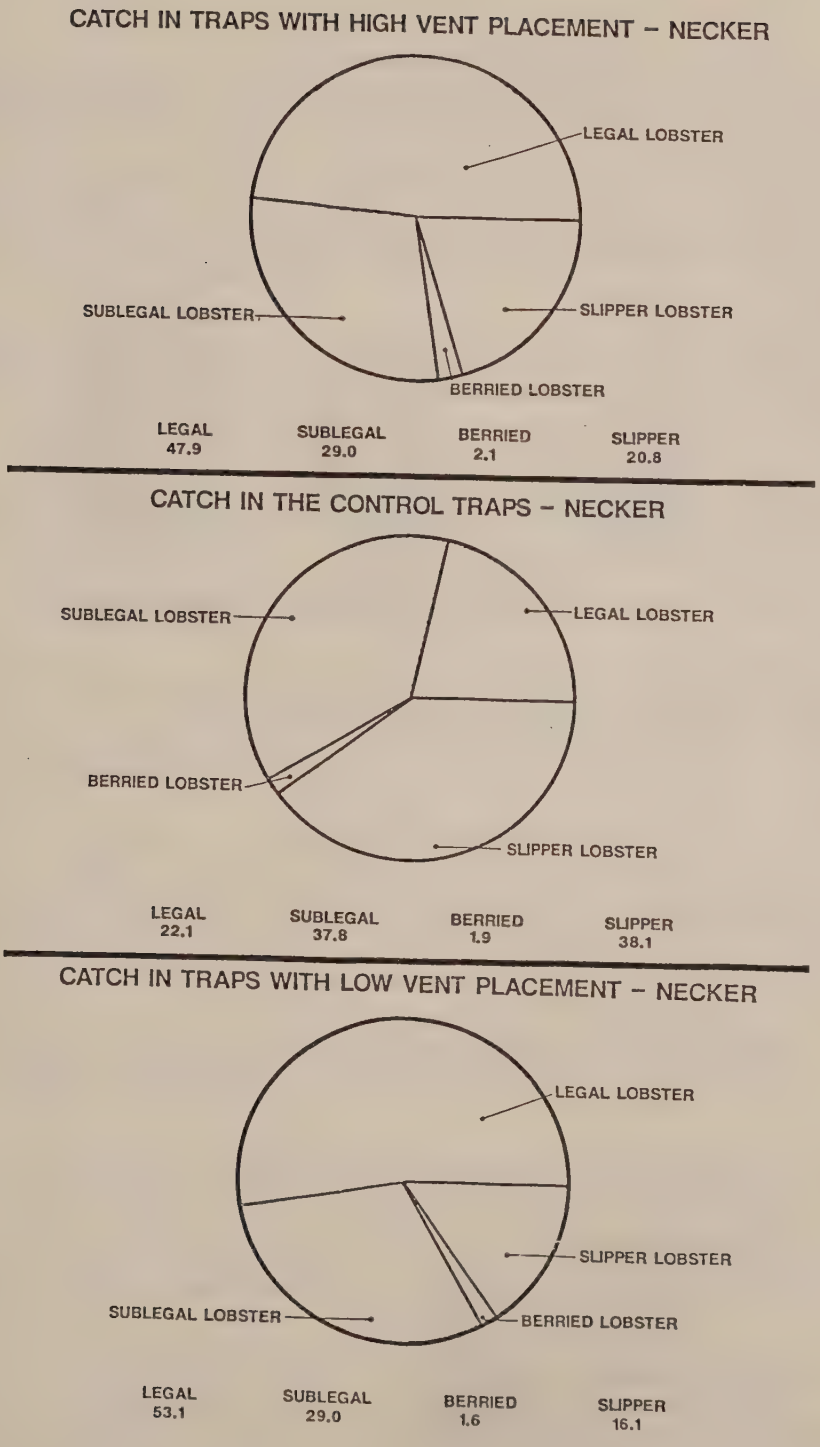

Figure 3.--Results of experimental fishing at Necker Island with traps having escape vents and control traps without vents on cruise of the Townsend Cromwell in November-December 1985.

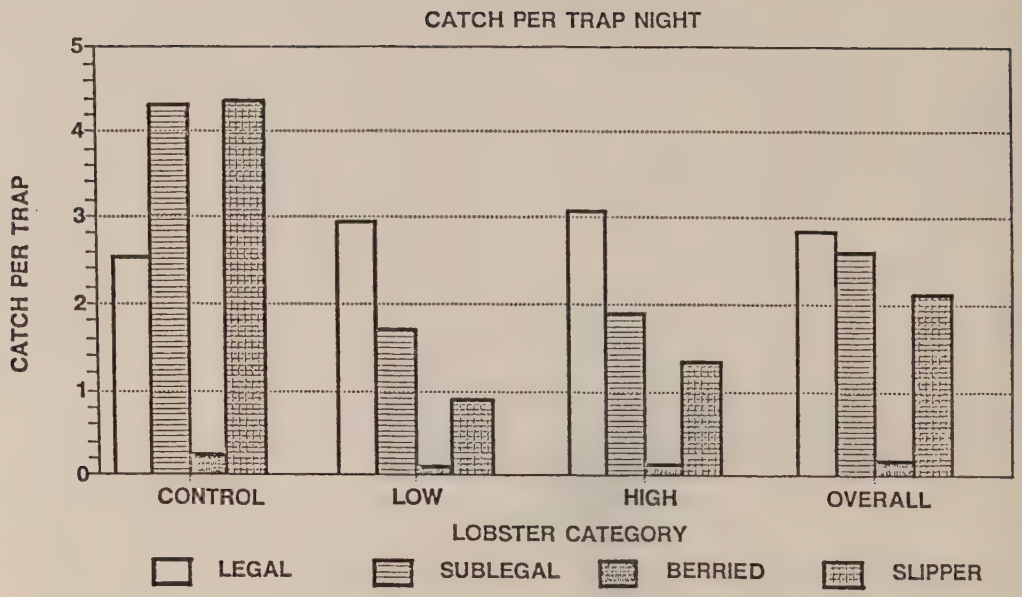

Figure 4.--Combined catch data at Necker Island during cruise of the Townsend Cromwell, November-December 1985.

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